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(19)

(54) PROCESS AND APPARATUS FOR THE PRODUCTION OF FILMS AND SHEETS OF THERMOPLASTIC MATERIAL

(71) We, KALLE AKTIENGESELLSCHAFT, a body corporate organised according to the laws of Germany, of 190-196 Rheingaustrasse, Wiesbaden-Biebrich, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention is concerned with a process and apparatus for the production of films and sheets by extruding thermoplastic materials, e.g. synthetic plastics.

It has not hitherto been possible in the manufacture by extrusion of films, sheets or tubular films, to avoid the formation of thicker areas caused by differences in the flow behaviour of the melt during extrusion. These thicker areas, which are always in the same position with reference to the length dimension of the die slot, are particularly annoying in the products, especially when films are wound up. When webs of film are taken up on a reel, thick bulges appear which are caused by the superimposed thicker areas of the film. The web of film becomes distorted in the region of the bulges, thus causing a further substantial deterioration of the flat quality of the film. Also when the films or sheets are to further processed, e.g. printed or laminated, such areas of increased thickness extending in the longitudinal direction of the film are very troublesome.

For these reasons, numerous attempts have been made to influence the melt during extrusion in order to reduce the thickness of the thicker areas and to distribute them transversely to the direction of extrusion. These attempts have shown that, although the thickness of these areas can be reduced by certain measures, they cannot be altogether avoided. Therefore, it has become the main object of all these investigations to achieve a more even distribution of the thicker areas.

In the production of blown films, measures are normally taken in order to cause the bulges appearing on the reel during take-up of the film to be displaced transversely to the direction of winding. This may be achieved, for example, by rotating or reversing the blow head, the cooling ring, or the flattening device. However, the means suitable for blown films cannot be applied to the extrusion of films or sheets from a slot die.

It has already been suggested to oscillate the slot die or one of the subsequent stations, e.g. the winding device, at a suitable amplitude transversely to the direction of transport. In addition to the increased expenditure required on apparatus, this would also cause an increase in waste, due to the wider margin which would have to be cut off, because, in order to produce straight edges, at least the distance corresponding to the lateral shift would have to be cut off at each side.

Therefore, it has become the object of most of these attempts to influence the flow behaviour of the melt. German Patent Specification No. 1,052,673 discloses a slot die for an extruder in which the melt is stirred during the extrusion process by means of an agitator disposed within the die. German Patent Specification No. 1,127,575 describes a modification of this agitator, in which all zones within the interior of the die are to be traversed by pins attached to the agitator. German Patent Specification (DAS) No. 1,194,125 deals with the arrangement of a screw in addition to an agitator. Further, German Patent Specification No. 1,232,335 describes a stirring rod arranged in the interior of the die as a means for stirring the melt. Still further, a slot die is known from Swiss Patent Specification No. 390,534, in which the stirring element arranged in the

The invention is illustrated diagrammatically by way of example in the accompanying drawings, in which:

Fig. 1 is an exploded perspective view of one form of slot die,

Figs. 2 to 4 are sections, taken along the lines II-II, III-III, and IV-IV of Fig. 1, of the die when in the assembled position.

Fig. 5 is a similar view to Fig. 1 of another embodiment of slot die,

Fig. 6 is an elevation of a detail of Fig. 5 and

Fig. 7 is a similar view to Fig. 1 of a still further embodiment of a slot die.

Referring to the drawings, Fig. 1 shows a die body 6 with die slot 5. A sleeve 3, which for the sake of clarity is shown outside the die body, is actually movably positioned within a bore of the die body and in the extrusion process executes a rotary motion in the direction A-A. The rotary motion may be an oscillating or a continuous revolving motion, an operating mechanism (not shown) attached to the sleeve being correspondingly designed. The motion imparted to the sleeve may be produced by known devices and transmitted to the sleeve likewise by known mechanical elements, such as cog wheels, toothed segments, eccentrics, connecting rods and the like. From an extruder (not shown), a melt 1 is fed through an opening 2 into the sleeve 3 and leaves it through an opening 4.

Since the sleeve performs a rotary motion, the whole mass is shifted to and fro across the elongate die slot. In this manner, the flow lines and, consequently, any thickened areas which form, move obliquely across the exit direction of the extruded film or sheet. The outlet opening 4 of the sleeve, as shown, is arranged in an oblique position to the die orifice and, in a preferred embodiment, passes around substantially the whole circumference of the sleeve.

Further, it has been found that it is of advantage in many cases to superimpose upon the rotary motion an axial motion of the sleeve, i.e. a displacement of the sleeve along the elongated die orifice, the sleeve being correspondingly dimensioned. In this manner, a particularly even distribution of the thickened areas is achieved. In this embodiment of the invention, the sleeve has customary mechanical elements attached to it to cause its rotary motion and axial motion

In a further embodiment of the last-mentioned apparatus, the inlet opening 2 passes right through the sleeve 3, so that part of the melt can issue from the opposite end of the sleeve, in addition to the portion emerging from the outlet opening 4

In a still further embodiment of the apparatus, in which the sleeve only performs a rotary motion, the inlet opening 2 and the bore within the die body 6 are of such construction that they pass through the whole die body. With this embodiment, the melt is fed in from both ends, using two extruders. By this construction, the torsion in the sleeve is reduced in a desired manner, particularly in the case of relatively long sleeves.

In Figs. 2 to 4, the position of the outlet opening 4 relative to the die seat 5 is shown in the various sections. It can be seen from these figures how the mass fed into the die is displaced with respect to the stationary die slot by the rotary movement of the sleeve.

Fig. 5 shows the same die body 6 and the same die slot 5 as in Fig. 1. In the assembled position, the melt 1 issuing from the extruder enters the sleeve 3 through the inlet opening 2 and leaves it through an outlet opening 8. During the extrusion of a film or sheet, an axial motion in the direction B-B is imparted to the sleeve by means of known devices. In order to avoid even minor dead zones within the die, at the outlet opening 8, the end 7 of the sleeve is preferably bevelled as shown (see also Fig. 6). In addition to the axial motion, a rotary motion may be simultaneously imparted to the sleeve, which may be in the form of a continuous rotation or an oscillation.

Fig. 6 is a detail of the sleeve of Fig. 5 in which the bevelled end 7 and the outlet opening 8 are shown as a plan view.

Fig. 7 shows still another embodiment of sleeve. In this case the die body 6 is shown without end plates. The melt 1 is fed into the inlet opening 2 of the sleeve 3 from the end opposite to the drive. The outlet opening 4 of the sleeve, which extends obliquely to the die slot 5, is in the form of an uninterrupted slot extending almost to the end of the sleeve. Rotary motion, in the indicated direction A-A, is imparted to the sleeve by means of a cog wheel 9.

In other embodiments, the outlet opening 4 may consist of closely adjacent perforations or of a combination of perforations and slots, instead of being in the form of a continuous slot.

WHAT WE CLAIM IS:—

1. A process for the manufacture of a sheet or film by extruding a molten thermoplastic material from an elongate slot die, wherein all the molten material is supplied from a continuously moving supply means to a chamber behind the slot via an entry area spaced from, and co-extensive with, the slot, the supply means comprising a hollow member having an entry opening for molten thermoplastic material and, in communication with said entry opening, one or

1,336,007
2 SHEETS

COMPLETE SPECIFICATION

This drawing is a reproduction of the Original on a reduced scale.

SHEET 1

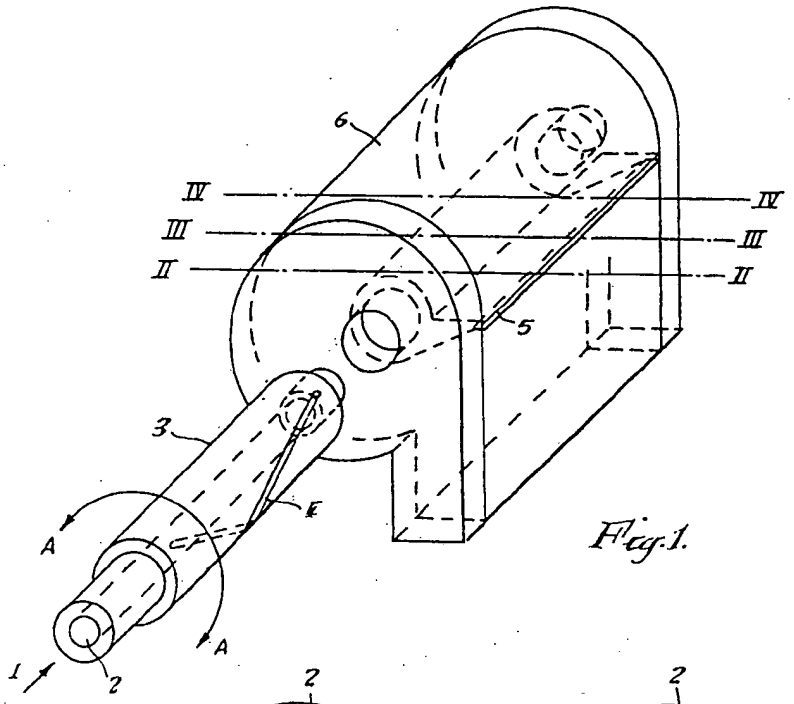

Fig. 1.

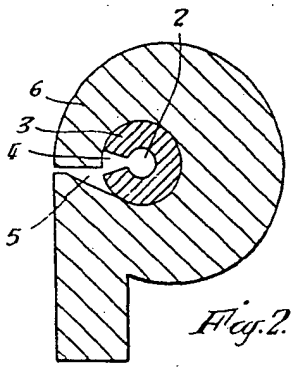

Fig. 2.

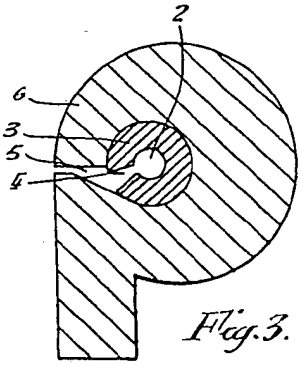

Fig. 3.

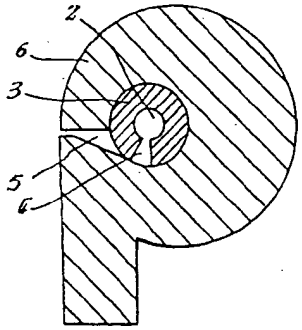

Fig. 4.